Sampling and Analysis Plan for Automated Synoptic Surface-Water and Sediment Sampling for the GS10 Source Investigation

FINAL

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Revision 0

1/39

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ACRONYMS

Am	Americium-241
AME	Actinide Migration Evaluation
APO	Analytical Project Office
AR	CERCLA Administrative Record
ASD	Analytical Services Division
ASI	Advanced Sciences, Inc.
CDPHE	Colorado Department of Public Health and the Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
D&D	Decontamination and Decommissioning (including demolition)
DER	Duplicate Error Ratio
DOE	U. S. Department of Energy
DQO	Data Quality Objective
EDD	Electronic Disc Deliverable
EMD	Environmental Management Department
EMSL	Environmental Monitoring Support Laboratory
EPA	U. S. Environmental Protection Agency
ER	Environmental Restoration
FID	Flame Ionization Detector
FIDLER	Field Instrument for the Detection of Low Energy Radiation
FO	Field Operations
GC/MS	Gas Chromatography/Mass Spectrometry
GPS	Global Positioning System
H_2SO_4	Sulfuric Acid
HNO_3	Nitric Acid
HRR	Historical Release Report
HSS	Health and Safety Specialist
IA	Industrial Area
IHSS	Individual Hazardous Substance Site
IMP	Integrated Monitoring Plan
ITS	Interceptor Trench System
K-H	Kaiser-Hill Company, L.L.C.
mg/L	milligrams per liter

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ml	milliliter
µg/L	micrograms per liter
µm	micrometer
NEPA	National Environmental Policy Act
OPWL	Original Process Waste Line
OU	Operable Unit
PA	Protected Area
PARCC	Precision, Accuracy, Representativeness, Completeness, and Comparability
pCi/L	picocuries per liter
POE	Point of Evaluation
PPE	Personal protective equipment
Pu	Plutonium-239,-240
QA/QC	Quality Assurance/Quality Control
QAPD	Quality Assurance Program Description
RCRA	Resource Conservation and Recovery Act
RCT	Radiological Control Technician
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RMRS	Rocky Mountain Remediation Services, L.L.C.
RPD	Relative Percent Difference
SAP	Sampling and Analysis Plan
SEP	Solar Evaporation Ponds
SOPs	Standard Operating Procedures
SPP	Solar Ponds Plume
SWD	Soil and Water Database
TAL	Target Analyte List
TCL	Target Compound List
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TSS	Total Suspended Solids
U	Total Uranium

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LIST OF APPLICABLE STANDARD OPERATING PROCEDURES (SOPs)

Identification Number	Procedure Title
1-PRO-079-WGI-001	*Waste Characterization, Generation, and Packaging*
2-S47-ER-ADM-05.14	*Use of Field Logbooks and Forms*
RMRS/OPS-PRO.127	*Field Decontamination Operations*
1-PRO-573-SWODP	*Sanitary Waste Offsite Disposal Procedure*
5-21000-OPS-FO.16	*Field Radiological Measurements*
RMRS/OPS-PRO.069	*Containing, Preserving, Handling and Shipping of Soil and Water Samples*
RMRS/OPS-PRO.070	*Equipment Decontamination at Decontamination Facilities*
RMRS/OPS-PRO.086	*Sediment Sampling*
RMRS/OPS-PRO.112	*Handling of Field Decontamination Water*
PADC-96-00003	*WSRIC for OU Operations, Version 6.0, Section 1*
RF/RMRS-98-200	*Evaluation of Data for Usability in Final Reports*
RM-06.02	*Records Identification, Generation and Transmittal*
RM-06.04	*Administrative Record Document Identification and Transmittal*

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1. INTRODUCTION

1.1 PURPOSE

This Sampling and Analysis Plan (SAP) provides for sampling activities for six sub-drainage areas at the Rocky Flats Environmental Technology Site (RFETS). This activity supports the ongoing Source Investigation activities being conducted in response to elevated water-quality measurements from the RFCA POE GS10 in South Walnut Creek (Figure 1-1). The scope of this SAP includes the following projects:

Project	Purpose
1) Automated Synoptic Surface-Water Sampling	Investigate spatial water-quality trends for sub-drainage areas tributary to POE GS10. These sub-drainages have been identified as potential contaminant source areas through the GS10 Source Evaluation effort.
2) Sediment Sampling	Investigate spatial sediment trends for sub-drainage areas tributary to POE GS10. These sub-drainages have been identified as potential contaminant source areas through the GS10 Source Evaluation effort.

The objective of this SAP is to define specific data needs, sampling and analysis requirements, data handling procedures, and associated Quality Assurance/Quality Control (QA/QC) requirements for these projects. All work will be performed in accordance with the Rocky Mountain Remediation Services (RMRS) Quality Assurance Program Description (QAPD) (RMRS, 1999c) and the Quality Assurance Program Plan for the Automated Surface-Water Monitoring Program (RMRS, 2000). Field activities planned under this SAP are limited to automated surface-water monitoring location installation, surface-water sampling, and sediment sampling. Routine automated surface-water sampling for long-term monitoring is accomplished by the Automated Surface-Water Monitoring Program as specified in the Integrated Monitoring Plan (IMP) (Kaiser-Hill, 1999a, 1999b).

This SAP incorporates information and data interpretations from previous investigations conducted as part of the GS10 Source Evaluation effort as a basis for designing and implementing each proposed field activity. This project will be performed in accordance with applicable federal, state, and local regulations, as well as U. S. Department of Energy (DOE) Orders, Rocky Flats Environmental Technology Site (RFETS) policies and procedures, and RMRS Operating Procedures.

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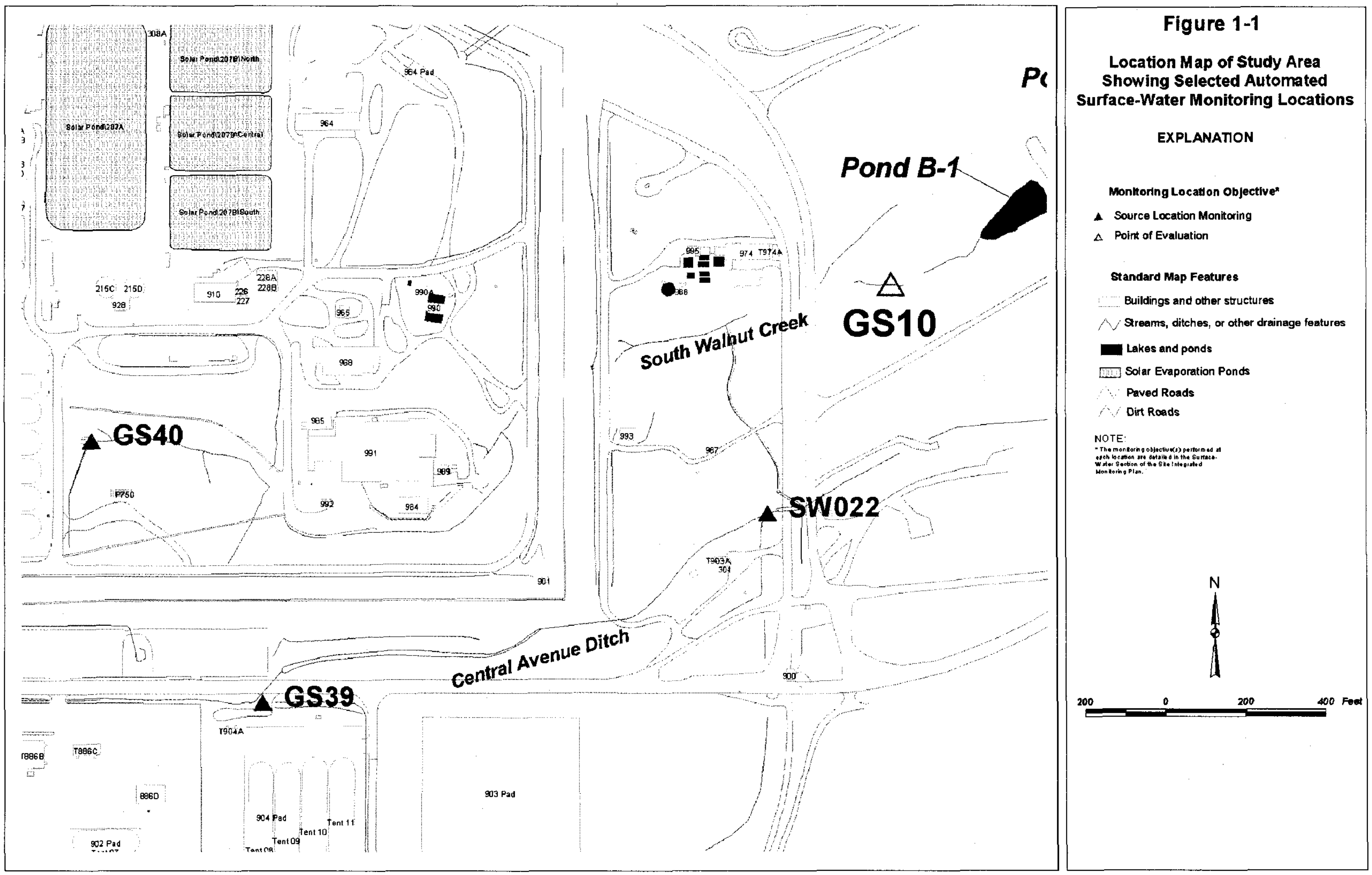

Figure 1-1. Location Map of Study Area Showing Selected Automated Surface-Water Monitoring Locations.

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1.2 BACKGROUND

1.2.1 Source-Evaluation for POE GS10

The Site has been conducting an ongoing Source Evaluation effort for POE GS10 in accordance with the *Final Rocky Flats Cleanup Agreement* (RFCA) (DOE, 1996) (Attachment 5, §2.4(B)) under "Action Determinations". The RFCA requires reporting "when contaminant concentrations in Segment 5 exceed the Table 1 action levels" and that "source evaluation will be required". Further, RFCA states "if mitigating action is appropriate, the specific actions will be determined on a case-by-case basis, but must be designed such that surface water will meet applicable standards at the POCs" (Points of Compliance).

Specifically, this Source Evaluation addresses multiple Rocky Flats Environmental Technology Site (Site) reports of elevated 30-day moving average results for plutonium (Pu-239,-240) and americium (Am-241) water-quality at the Point of Evaluation (POE; Segment 5) monitoring location above Pond B-1 (referred to as GS10) in South Walnut Creek. This Source Evaluation effort has produced multiple reports (RMRS, 1997c, 1997d, 1997e, 1998, 1999b) in an attempt to identify discrete source areas associated with the elevated water-quality measurements at GS10.

Site personnel have evaluated historical data, collected additional water samples for analyses, and assessed Site activities as part of this Source Evaluation. Site personnel have concluded that the likely source of the elevated measurements of the 30-day average for Pu and Am at GS10 is diffuse low-level radionuclide contamination released to the environment from past Site operations. The best evidence indicates that the source area of this contamination is thought to be the sub-drainage that feeds only GS10, and not the other directly monitored sub-drainages tributary to GS10.

Site soils have received radionuclide contamination from various historical practices and legacy releases. Section 4.7 in Progress Report #2 (RMRS 1997d) identifies various events from the Site's production era which introduced radionuclides to Site drainages via both airborne and surface-water runoff pathways. As discussed in Section 4 of Progress Report #2, historical reports and a recent review of existing soil/sediment data indicate diffuse low-level Pu and Am contamination of soils and sediments occurs in the GS10 drainage. The GS10 drainage includes various IHSSs and actinide source areas which could provide source terms for elevated levels in surface water. The movement of contaminated soils and sediments in runoff could result in localized deposits or diffuse contamination, depending on natural erosion processes in the GS10 drainage.

Actinide Migration Evaluation (AME) results to-date suggest that transport of dissolved Pu and Am is not a significant pathway at the Site, and physical transport of particulate-borne radionuclides is likely primarily responsible for Pu and Am mobilization (Santschi, 1999). The ramifications of these findings as related to specific mechanisms of transport will be further developed by additional AME research

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currently underway. The surface-water RFCA Source Evaluation task team continues to consult regularly with the AME Team and remains up-to-date on the latest findings as well as recommended areas of research.

Section 4.2 of Progress Report #2, Section 6.1.2 of the Final Report (RMRS 1998), and Section 4.1.3 of the 1999 GS10 Source Evaluation Report (RMRS 1999b) show that the directly monitored GS10 sub-drainages all contribute actinide load to GS10, further supporting the hypothesis of multiple or diffuse source areas. Data collected from monitoring locations GS27, GS38, GS39, GS40, and SW022 further determined the proportions of actinide load that each directly monitored sub-drainage may be contributing to GS10.

The loading evaluation in Section 4.1.3 of the 1999 GS10 Source Evaluation Report (RMRS 1999b) showed that the GS27, GS38, GS39, and GS40 sub-drainages contribute approximately 23% of the total Pu load reaching GS10. Similarly, the evaluation showed that the GS27, GS38, GS39, and GS40 sub-drainages contribute approximately 8% of the total Am load reaching GS10. Other sub-drainages not directly monitored contribute the remaining Pu and Am load measured at GS10. These other sub-drainages include the South Walnut Creek reach between GS40 and GS10, a portion of the 500 Area outside the PA, portions of the 800 Area, and the Central Avenue Ditch reach between GS38 and SW022. That SW022 has shown relatively high Pu activities, coupled with the proximity of the 903 Pad[1], indicates that the Central Avenue Ditch reach between GS38 and SW022 may be a significant source of Pu. The limited soil and sediment data in for this area also show higher Pu activities compared to other areas in the GS10 drainage.

Figure 4-8 in the 1999 GS10 Source Evaluation Report incorporates the Am data from SW022 and indicated that the SW022 sub-drainage (which includes GS27, GS38, and GS39) contributes 24% of the Am load to GS10, with an additional 4% being contributed from the GS40 sub-drainage. This further suggests that the South Walnut Creek reach between GS40 and GS10 may contain a significant source of Am. The soil and sediment data that exists for this area shows relatively higher Am activities for areas south and east of the Solar Ponds. The *Historical Release Report* (DOE 1992) supports the hypothesis that actinide contamination exists in the drainage immediately upstream of GS10, specifically the sediments in the stream reach between B991 and GS10. The area was identified in the *HRR* due to past radioactive releases to the B-series drainages (as discussed in Section 4.7 of Progress Report #2), and the soil in the area is potentially contaminated with actinides.

Results in Section 4.1.2 of the 1999 GS10 Source Evaluation Report also indicate that the average Pu/Am activity ratio from surface-water samples at GS10 is lower than that generally observed in other

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[1] GS39, which directly monitors runoff from the 903 Pad area, shows only moderate actinide transport.

drainages and sub-drainages across the Site. Results also indicated that the Pu/Am ratios observed at GS10 appear to be distinguishable from those observed in the directly monitored sub-drainages tributary to GS10. These results suggest that a source of contamination with a low Pu/Am ratio exists within the GS10 drainage, either very close to the GS10 monitoring location or in a sub-drainage not directly monitored by upstream surface-water monitoring locations. The limited soil/sediment data from the sampling locations south and east of the Solar Ponds show ratios where Am exceeds Pu, possibly indicating a historical release of Am to the environment in this area.

Specifically, the Source Evaluation to date has concluded the following:

- Readings from *in-situ* water-quality monitoring probes indicate no unusual or unexpected conditions during the periods of elevated measurements.

- Recent Site activities suggest that neither D&D, ER, excavation, nor routine operations during the event periods caused a release of Pu or Am that resulted in the elevated activities measured at GS10.

- Surface-water and soil/sediment sampling results indicate that one or more low-level distributed actinide source areas exist within the GS10 drainage. Further, surface-water activities have been of similar magnitudes for the last decade, suggesting source areas that originated as legacy contamination.

- Surface-water sampling results from GS10 show Pu/Am activity ratios that are distinguishable from Pu/Am ratios at other surface-water monitoring location at the Site. This suggests that a source relatively 'enriched' in Am may exist in the GS10 drainage.

- Recent surface-water sampling results from Source Location monitoring stations have further refined the estimation of relative Pu load contributions to GS10 from upstream sub-drainage areas. These load estimations suggest that Pu source terms may exist in the following sub-drainage areas:
    1. The Central Avenue Ditch reach between surface-water monitoring locations GS38 and SW022;
    2. Portions of the 800 Area;
    3. A portion of the 500 Area outside the PA; and
    4. The South Walnut Creek reach between surface-water monitoring locations GS40 and GS10.

- Recent surface-water sampling results from Source Location monitoring stations have further refined the estimation of relative Am load contributions to GS10 from upstream sub-drainage areas. These load estimations suggest that Am source terms may exist in the following sub-drainage areas:
    1. A portion of the 500 Area outside the PA; and

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2. The South Walnut Creek reach between surface-water monitoring locations GS40 and GS10.

- Soil and sediment data in the GS10 drainage show the following items of interest:
  1. Relatively higher Pu activities exist in the sub-drainage areas near the 903 Pad which are tributary to SW022 and subsequently GS10; and
  2. The Pu/Am ratios for sampling locations near the Solar Ponds indicate a source that may be relatively 'enriched' with Am.

1.3 HYDROGEOLOGIC SETTING

1.3.1 Hydrology

North and South Walnut Creek Surface-Water Flow Routing

All IA surface-water runoff that flows into North or South Walnut Creek is collected by a system of Site stormwater detention ponds. The ponds serve three main purposes for surface-water management: (1) storm water detention and settling of sediments, (2) water storage for sampling and, if necessary, treatment prior to release, and (3) emergency spill control in those instances where a spill cannot be adequately managed without use of the ponds.

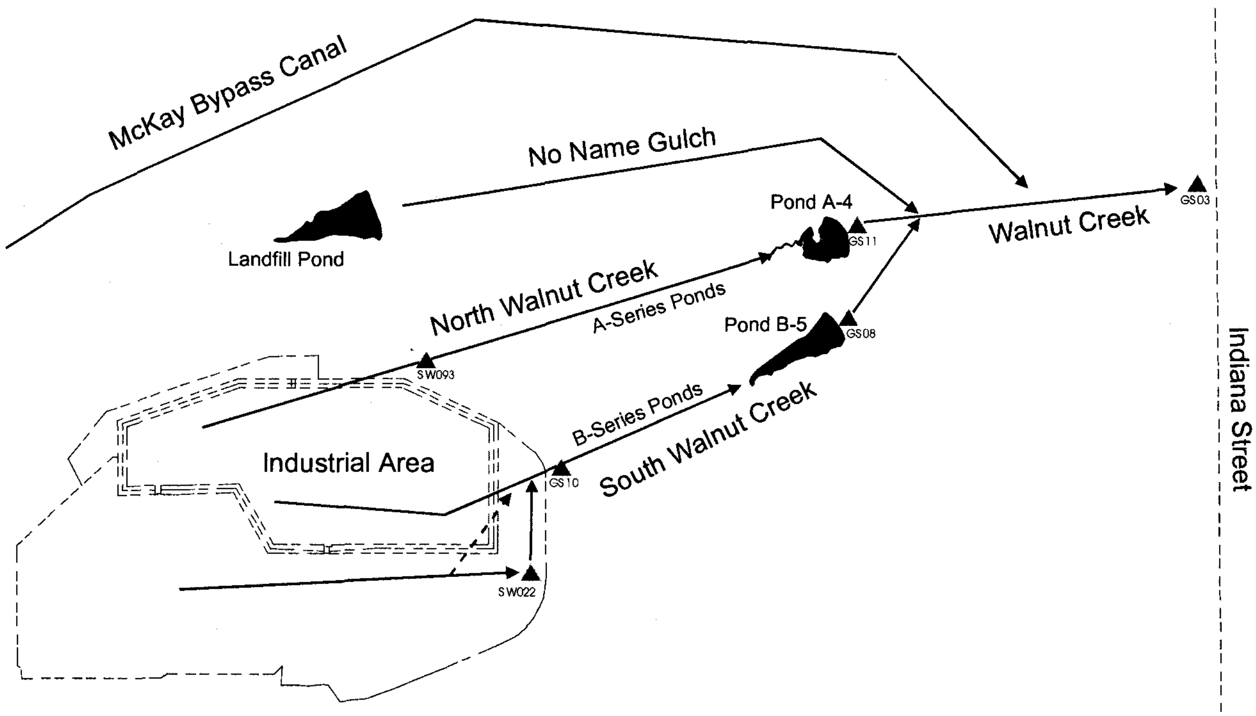

Figure 1-2. Hydrologic Connectivity of Site Drainage and Water Management Features.

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South Walnut Creek water is routed through the B-Series ponds. Steps in the water collection and transfer process are briefly outlined as follows:

- Runoff from the south-central IA flows through the Central Avenue Ditch past monitoring location SW022, and then past GS10 (during high runoff periods, some water in the Central Avenue Ditch overflows to a large corrugated metal pipe and flows directly to GS10; shown by dotted line in Figure 1-2);

- Runoff from the central IA flows directly to GS10;

- Runoff from GS10 then flows downstream through conveyance structures, through Pond B-4, and then to Pond B-5 where it is held; and

- The Site discharges water held in Pond B-5 periodically in batches to Walnut Creek.

As indicated above, all of the IA runoff that flows into South Walnut Creek is ultimately routed through Pond B-5, detained, and sampled prior to being released to lower Walnut Creek. There is no source of IA runoff that can enter Walnut Creek without first passing through the pond system for discharge from Pond B-5. Downstream from Pond B-5, the only sources of surface-water entering Walnut Creek upstream of the Site boundary are North Walnut Creek (through Pond A-4), No Name Gulch, the McKay Bypass Canal, or overland runoff directly into Walnut Creek.

2. DATA QUALITY OBJECTIVES

The data quality objective (DQO) process consists of seven steps and is designed to be iterative; the outputs of one step may influence prior steps and cause them to be refined. Each of the seven steps is described below for the investigative area shown in Figure 1-1. Data requirements to support these projects were developed and are implemented in the projects using criteria established in *Guidance for the Data Quality Objective Process*, QA/G-4 (EPA 1994).

2.1 STATE THE PROBLEM

2.1.1 Synoptic Surface-Water Sampling

The GS10 Source Evaluation has indicated that the area shown in Figure 1-1 is likely a contributor of surface-water runoff transporting Pu and Am load to GS10. The relative surface-water actinide contributions from the sub-drainages in this area are unknown. Knowledge of the relative surface-water contributions could indicate the sub-drainage areas where source areas may be present, allowing for mitigation efforts or more focused subsequent investigation.

This investigation will determine the spatial variability of surface-water activities as an indication of the potential location of relatively discrete actinide source areas.

2.1.2 Sediment Sampling

The GS10 Source Evaluation has indicated that the area shown in Figure 1-1 is likely a contributor of surface-water runoff transporting Pu and Am load to GS10. Pu and Am typically associate with particulate matter that is transported as suspended solids in surface water. The relative sediment activities in the sub-drainages in this area are not well characterized. Knowledge of the relative sediment activities may identify sub-drainage areas where source areas may be present, and allow mitigation efforts or more focused subsequent investigation.

This investigation will investigate the spatial variability of actinide in sediment that is available for transport in surface water. This variability could serve as an indication of the potential location of relatively discrete actinide source areas.

2.2 IDENTIFY THE DECISION

2.2.1 Synoptic Surface-Water Sampling

Decisions required to be made using surface-water field and analytical data collected from synoptic sampling locations include:

- Do surface-water sample results from synoptic samples indicate spatial trends that point to sub-drainages that may contain Pu and/or Am source areas?
- Do Pu/Am activity ratios for surface-water sample results from synoptic samples indicate sub-drainage areas that may be relatively 'enriched' in Am?
- Do water-quality correlations for surface-water sample results from synoptic samples show similar traits to correlations from GS10 during periods of elevated surface-water measurements at GS10?

2.2.2 Sediment Sampling

Decisions required to be made using sediment analytical data collected from sampling locations include:

- Do sediment sample results indicate spatial trends that point to sub-drainages that may contain Pu and/or Am source areas?

- Do Pu/Am activity ratios for sediment sample results indicate sub-drainage areas the may be relatively 'enriched' in Am?

- Do sediment characteristics show similar traits to characteristics for TSS from GS10 during periods of elevated surface-water measurements at GS10?

2.3 IDENTIFY INPUTS TO THE DECISION

2.3.1 Synoptic Surface-Water Sampling

Inputs to the decision include hydrological field observations (storm-event characteristics); Pu, Am and U analytical results for synoptic surface-water samples; other water-quality results based on the analyte suite; and the tributary sub-drainage delineation for each sampling location. The parameters of interest include:

- Field data, conditions, weather;

- Surface-water Pu and Am activities;

- Other surface-water analytes including TSS, total metals, TOC, TDS, hardness, silica, fluoride, and sulfate; and

- Delineation of surface-water sub-drainage areas for each sampling location.

A listing of the analytes of interest, including sample quantities and analytical methodology, are outlined in Table 3-3.

2.3.2 Sediment Sampling

Inputs to the decision include geological field observations (sample media characteristics); Pu and Am analytical results for sediment samples; other sample analytes to be determined; and the tributary sub-drainage delineation for each sampling location. The parameters of interest include:

- Field data, conditions, weather;

- Sediment Pu and Am activities;

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- Other sediment analytes to be determined depending on the characteristics of GS10 TSS; and
- Tributary sub-drainage delineation for each sampling location.

A listing of the analytes of interest, including sample quantities and analytical methodology, are outlined in Table 3-4.

2.4 DEFINE THE BOUNDARIES

2.4.1 Synoptic Surface-Water Sampling

The investigative boundaries and rationale for this project are detailed in Section 3.2 of this SAP (also see Figure 1-1, Figure 3-2 and Table 3-1).

2.4.2 Sediment Sampling

The investigative boundaries and rationale for this project are detailed in Section 3.3 of this SAP (also see Figure 1-1 and Figure 3-3).

2.5 DECISION RULE(S)

2.5.1 Synoptic Surface-Water Sampling

The decision rule for determining which sub-drainage areas are contributing significant actinide load(s) will be based on a comparison of analytical results from all locations for identical runoff events. By sampling the same event at multiple locations as it moves through the drainage, the variations in water quality due to hydrologic variations will be minimized. In this way, the concentrations can be compared directly with consideration given to sub-drainage size. Statistical inference[2] will be used to assess different concentrations of actinides at certain locations that may indicate that Pu and/or Am contamination exists in the sub-drainage tributary to that location. Additional sampling and analyses could then be targeted for the suspected sub-drainage in an iterative attempt to locate discrete source areas.

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[2] Statistical inference is the process of using information contained in the observed sample to draw conclusions about the population/process from which the sample was taken. Inferences are made regarding the parameters of the population. This process will include the use of parametric and non-parametric statistics, ranking, comparative visual assessment (plotting), spatial GIS assessment, etc.

In addition, statistical inference will be used to assess Pu/Am ratios at certain locations that may indicate that actinide contamination 'enriched' in Am exists in the sub-drainage tributary to that location. Likewise, water-quality correlations for surface-water sample results from synoptic samples will be compared to correlations from GS10 during periods of elevated surface-water measurements at GS10. Strong correlations will indicate that actinide contamination reaching GS10 may exist in the sub-drainage tributary to that location.

Decision Rule Summary for Synoptic Surface-Water Sampling:

- If Pu and Am activity-concentrations of synoptic samples from a particular sampling location indicate, through statistical inference, that the location-specific sub-drainage may contain source areas, then an evaluation of the specific sub-drainage area will be considered to further define or resolve the location of discrete source areas in that sub-drainage. This evaluation may include selective sediment and/or grid-based surface-soil sampling to locate 'hot spots'.

- If Pu/Am activity ratios of synoptic samples from a particular sampling location show ratios that are less than 1.5, then an evaluation of the specific sub-drainage area will be considered to further define or resolve the location of discrete 'Am-enriched' source areas in that sub-drainage. This evaluation may include selective sediment and/or grid-based surface-soil sampling to locate 'hot spots'.

- If water-quality correlations for synoptic samples from a particular sampling location show correlations that are similar to correlations for GS10 during periods of elevated Pu and/or Am activities, then an evaluation of the specific sub-drainage area will be considered to further define or resolve the location of discrete source areas in that sub-drainage. This evaluation may include selective sediment and/or grid-based surface-soil sampling to locate 'hot spots'.

2.5.2 Sediment Sampling

The decision rule for determining which sub-drainage areas are contributing significant actinide load will be based on a comparison of analytical results from sediment sampling locations at the end of defined ditches or streambeds (transects; see Section 3.3.1). Statistical inference will be used to assess concentrations of actinides at certain locations that may indicate that actinide contamination exists in the sub-drainage tributary to that location. Appropriate analyses of the upstream samples collected at uniform distances along the transects will then be completed to provide additional resolution. Additional sampling and analyses will then be considered for the suspected sub-drainage area in an iterative attempt to locate discrete source areas.

In addition, statistical inference will be used to assess the Pu/Am ratios at certain locations that may indicate that actinide contamination 'enriched' in Am exists in the sub-drainage tributary to that location.

Decision Rule Summary for Sediment Sampling:

- If Pu and Am activity-concentrations of sediment samples from a particular sampling location indicate, through statistical inference, that the location-specific sub-drainage may contain source areas, then analyses of the upstream samples collected at uniform distances along the transects will then be completed to provide additional resolution. Additional evaluation of the specific sub-drainage area will be considered to further define or resolve the location of discrete source areas in that sub-drainage. This evaluation could include selective-transect sediment and/or grid-based surface-soil sampling to locate 'hot spots'.

- If Pu/Am activity ratios of sediment samples from a particular sampling location show ratios that are less than 1.5, then analyses of the upstream samples collected at uniform distances along the transects will then be completed to provide additional resolution. Additional evaluation of the specific sub-drainage area will then be considered to further define or resolve the location of discrete 'Am-enriched' source areas in that sub-drainage.. This evaluation could include selective-transect sediment and/or grid-based surface-soil sampling to locate 'hot spots'.

2.6 DECISION LIMITS

To minimize decision errors, all field work will be performed in accordance with approved RMRS standard operating procedures. These procedures specify methods and equipment for ensuring the accuracy and integrity of sampling installations, field parameter measurements, sampling, and other related field data collection activities. A listing of applicable SOPs is provided at the beginning of this document.

2.6.1 Synoptic Surface-Water Sampling

Confidence in differentiating spatial water-quality trends depends on sampling location installation success, collection of representative samples using consistent techniques, and quality control.

Sample intake[3] installation is a key aspect of the monitoring program because sediments that are not suspended in the water column can easily be deposited in the sample container if the intake is contacting streambed sediments. Decision errors related to sample intake placement will be minimized by ensuring that the intake is placed at a representative depth in the water column and is not in close proximity to the streambed sediments.

Similarly, level sensor installation is a key aspect of the monitoring program because a successful synoptic sampling event requires that all of the samplers trigger to effectively sample the same runoff event. Decision errors related to level sensor placement will be minimized by ensuring that the level sensor is placed at the point of zero flow (pzf) at each sampling location.

2.6.2 Sediment Sampling

Confidence in differentiating spatial sediment contamination trends depends on sampling location selection, collection of representative samples using consistent techniques, and quality control.

Sediment sampling will occur along transects, with the transects defined as sections of ditches or streams that convey surface water from defined sub-drainages. The initial sediment sampling location for each transect will be chosen to represent the downstream end of a specific sub-drainage just upstream from the confluence with the next higher order channel. The other sampling points along the transect are then equally spaced from the initial point until the end of the transect is reached. Decision errors related to sample location placement will be minimized by ensuring that the transects are clearly defined and accurate maps are used to locate sampling locations.

2.7 OPTIMIZE THE DESIGN

2.7.1 Synoptic Surface-Water Sampling

Monitoring program design will be optimized through 8 years of technical experience and the application of automated monitoring equipment capable of collecting samples only during runoff events. This will allow for opportunistic sampling of runoff events continuously, while minimizing field visitation. Instrumentation is capable of remotely logging runoff event information so that only samples that meet the specific, representative, hydrologic criteria will be collected and analyzed.

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[3] The sample intake is a stainless steel strainer on the end of the suction line leading to the peristaltic pump on the automated sampler. The pump draws water from the stream and deposits the water into the sample container.

2.7.2 Sediment Sampling

The sediment sampling will be targeted to only sample material that is the most available for surface-water transport. Walkdowns and process knowledge will be employed to target locations which flow routinely and show evidence of sediment transport. Initially, only samples from the downstream ends of ditches and streams (transects) will be analyzed. The results from these initial (Priority 1) analyses will determine whether the upstream sampling points for each transect (Priority 2) will be subsequently analyzed, thus efficiently utilizing analytical resources.

3. SAMPLING RATIONALE, ACTIVITIES, AND METHODOLOGY

Section 3 presents the rationale and methodology for sampling activities proposed for the two projects. To improve continuity, the sampling rationale section usually presented before the Data Quality Objective section has been incorporated into the sampling and activities section. Section 3.1 describes the steps that must be taken prior to surface-water equipment installation and sample collection. Sections 3.2 and 3.3 describe the sampling rationale and proposed sampling activities for each project. Finally, Section 3.4 describes the procedures that will be used for equipment decontamination and waste handling.

3.1 PRE-SAMPLING ACTIVITIES

Health and Safety protocols will be followed in accordance with applicable Health and Safety Plans or RFETS Site SAR, as appropriate.

Release Evaluations will be completed for each new sampling location. Radiological surveillances will be performed during sample collection for locations that cannot be sufficiently characterized with historical data by the Release Evaluation. All samples from new sampling locations will require radiological screening prior to shipment offsite. Release Evaluations are complete for locations GS10 and SW022; neither surveillance nor screening will be required for these locations.

3.2 AUTOMATED SYNOPTIC SURFACE-WATER SAMPLING

The following factors were considered in developing the sampling strategy for the synoptic surface-water sampling:

- The Source Evaluation efforts to date (Section 1.2) indicate that the study area may be a significant contributor of actinide load to GS10. Analysis also indicates that a source relatively 'enriched' in Am may exist in the study area.

- Environmental data and AME research to date (Section 1.2) indicate that actinide moves through the environment attached to soil particles, and that this soil is transported in surface-water as TSS.

- Automated surface-water sampling data indicate that the majority of actinide transport in surface water occurs during runoff periods immediately following precipitation events as TSS concentration in surface water increases. These data also indicate that the actinide transport varies depending on the hydrologic characteristics of the precipitation events.

3.2.1 Surface-Water Sampling Locations and Rationale

Six automated surface-water sampling locations (SW021, SW022, SW023, SW060, SW132, and SW100100) have been chosen to evaluate storm-event runoff water quality. These locations correspond to sub-drainage areas that are defined by manmade hydraulic structures and may contribute actinide load to GS10. Figure 3-1 illustrates the location of these monitoring locations. Figure 3-2 shows the corresponding sub-drainage areas for each monitoring location. The rationale for each monitoring location is summarized in Table 3-1.

3.2.2 Location Design and Installation

Site personnel will install instrumentation at the monitoring locations shown in Figure 3-1. Typical equipment for each station will include an ISCO® flow meter[4] controlling an ISCO® portable automated sampler. Sampler intakes must be positioned such that representative samples are collected at each station.[5] Intakes and level sensors will be fastened to existing concrete or metal stormwater conveyance structures. Power for the instrumentation will be provided by solar/DC power systems.

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[4] Flow meters will measure level only. Flow control structures (e.g. weirs, flumes) will not be installed. Level measurement will be used to trigger automated sampling and to assess sampling periods as related to runoff hydrographs. Samplers will be triggered when water levels rise to exceed the current baseflow level.

[5] Intakes are positioned to collect only water that flowed through the stream or culvert to be monitored. The intakes must be secured high enough off the streambed so as not to collect non-representative sediment quantities, but low enough to be submerged during near zero flow rates. Attempts are also made such that intake position minimizes the effects of freezing conditions.

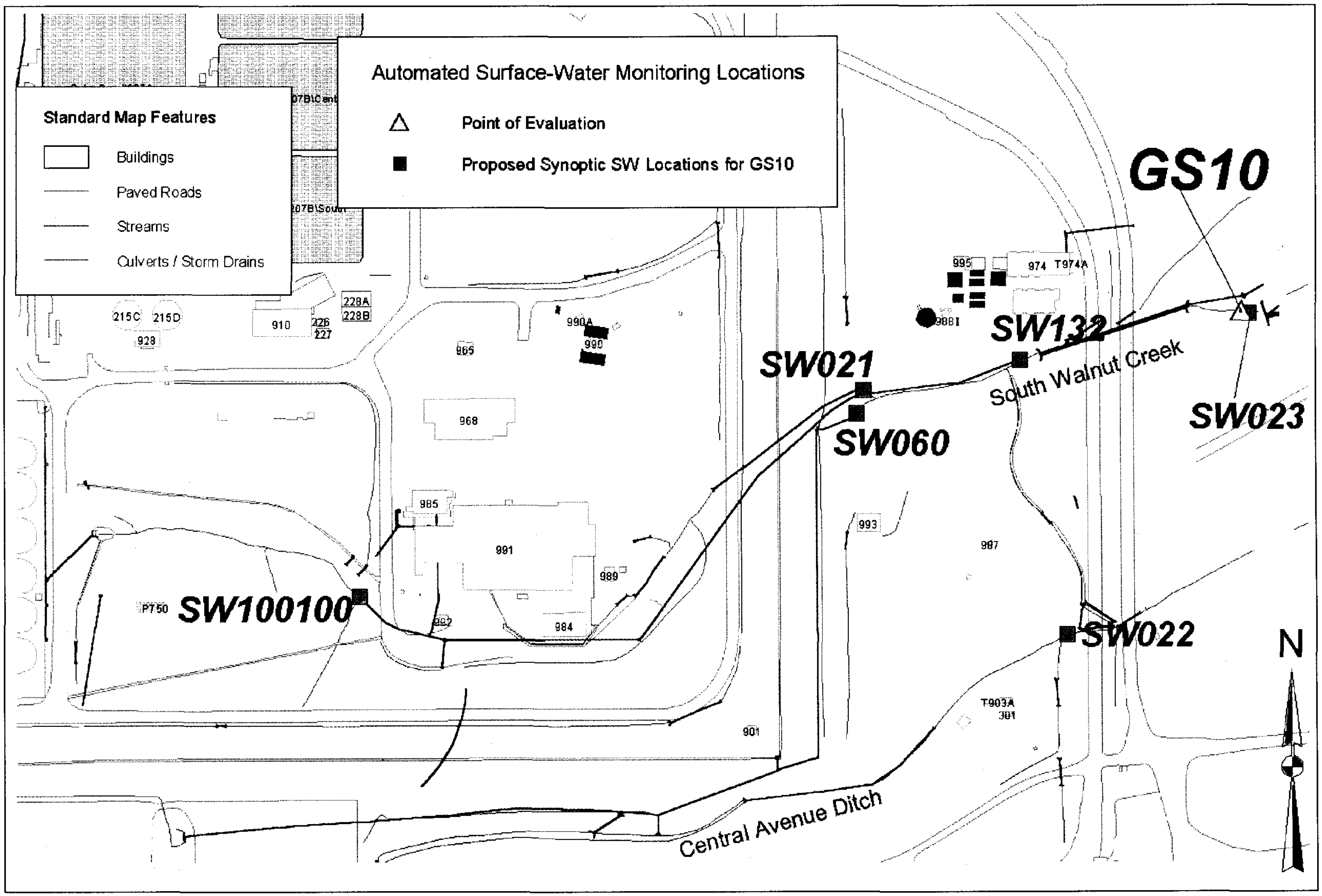

Figure 3-1. Location of Automated Synoptic Surface-Water Sampling Locations.

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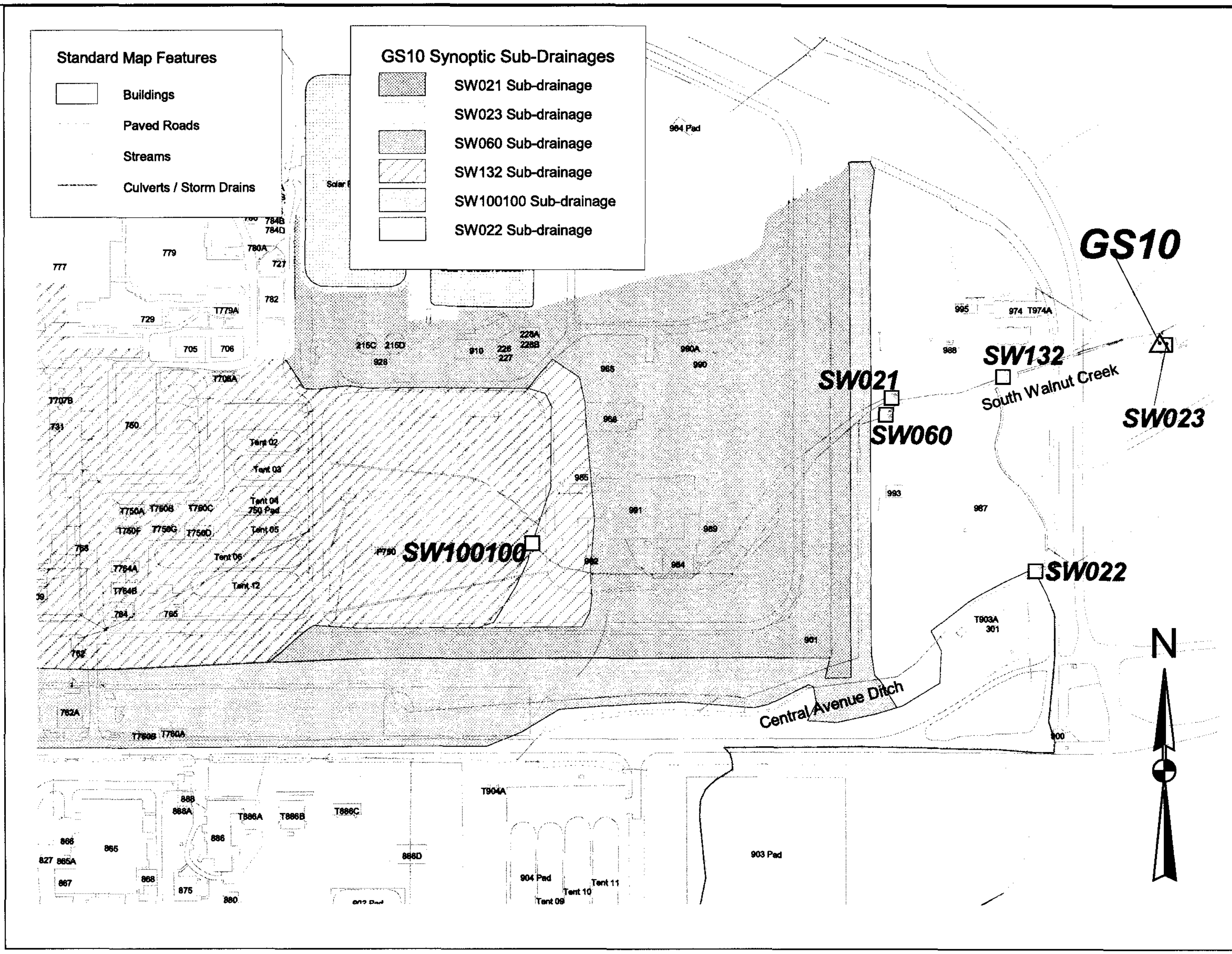

Figure 3-2. Sub-Drainage Areas for Automated Synoptic Surface-Water Sampling Locations.

Table 3-1. Automated Synoptic Surface-Water Sampling Location Rationale.

Location Code	Location Description (see Figure 3-2)	Rationale
GS10	POE on S. Walnut Creek just upstream from the B-1 Bypass	The continuous flow-paced samples collected under RFCA will be analyzed for additional parameters (Table 3-3) in support of the data evaluation for the synoptic sampling. No changes will be made to existing sample collection protocols.
SW023	Co-located with GS10 on S. Walnut Creek just upstream from the B-1 Bypass	This location will collect samples representative of all surface water from the GS10 drainage. Samples collected at GS10 are continuous flow-paced, and therefore cannot be compared directly to the event samples to be collected at the upstream locations. Approximate Drainage Area: 168 acres
SW132	At end of corrugated metal pipe draining area east of 750 Pad and west of B991; includes western portion of B991 and any unknown inflows to this pipe from area around B991	At a manmade structure providing a singular outfall to a specific sub-drainage; Approximate Drainage Area:33.1 acres
SW021	Outfall of culvert draining area inside PA downstream from 750 Pad	At a manmade structure providing a singular outfall to a specific sub-drainage; specifically areas nearest the Solar Ponds and B991; Approximate Drainage Area: 20.1 acres
SW060	Outfall of corrugated metal pipe draining areas east and south of PSZ; includes areas east of B551	At a manmade structure providing a singular outfall to a specific sub-drainage; Approximate Drainage Area: 25.7 acres
SW022	Eastern end of Central Avenue Ditch before diversion to S. Walnut Creek	At a manmade structure providing a singular outfall to a specific sub-drainage; specifically areas nearest the 903 Pad; Approximate Drainage Area: 77.9 acres
SW100100	Upstream end of corrugated metal pipe leading to SW132	On a stream just before entering a manmade structure providing a singular outfall to a specific sub-drainage; specifically areas between the 750 Pad and B991; Approximate Drainage Area: 31.1 acres

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3.2.3 Sample Designation

The Site-standard sample numbering system (ASD-003, *Identification System for Reports and Samples*) will be used for this project. Location codes have been assigned to individual sampling locations as shown in Figure 3-1 and listed in Table 3-1. For each surface-water sample a standard RIN sample number (i.e., 00XXXXX.00X.00X) will be assigned to the project by the Site's Analytical Services Division (ASD) for sample tracking.

3.2.4 Sample Collection

Synoptic surface-water sampling will begin after all monitoring locations are installed and operational. The six (6) temporary monitoring locations (shown in Figure 3-1) will be used to synoptically[6] sample storm-event runoff at various locations along S. Walnut Creek and the Central Avenue Ditch in the GS10 drainage. Each automated sampler will be triggered as the storm runoff reaches them, effectively sampling the same 'plug' of water. If all samplers do not sample the same storm runoff hydrograph, the samples will be discarded and the samplers will be reset for the next runoff event.[7] Automated samplers will used to collect 15 time-paced grabs in a 15-liter carboy. The chosen time pacing will be specific to each location such that the location collects the composite sample over the entire direct runoff period.[8] Determination of this time-pacing will be based on past experience and through trial-and-error as the hydrologic characteristics of each location become apparent.

Ideally, the locations should be operating during the normally wettest months (Apr-Jun) to collect samples of rainfall runoff for various sized storm events. Multiple events will be targeted with the goal of evaluating the results of five(5) successfully sampled events.

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[6] Synoptic sampling for this project is defined as the collection of samples over a broad area at a single given time. For this project, the single given time is defined as the same time period during a specific stormwater runoff event.

[7] It is necessary that the same hydrological event be sampled in a similar fashion at each location so that the measured water-quality results can be compared directly without the incorporation of flowrate, which cannot be accurately gaged without the construction of flow-control structures (e.g. weirs, flumes).

[8] Direct runoff is defined as the runoff attributed to a precipitation event in excess of the current baseflow.

Table 3-2. Automated Sampling Protocols for Synoptic Surface-Water Sampling.

Location Code	Sample Type	Number of Grabs / Composite	Grab Size
GS10	Continuous flow-paced composites	Varies depending on flow volume during targeted sample collection period.	200 ml
SW023	Time-paced composites during entire direct runoff period[a]	Up to 15 maximum[b]	1 liter
SW132	Time-paced composites during entire direct runoff period[a]	Up to 15 maximum[b]	1 liter
SW021	Time-paced composites during entire direct runoff period[a]	Up to 15 maximum[b]	1 liter
SW060	Time-paced composites during entire direct runoff period[a]	Up to 15 maximum[b]	1 liter
SW022	Time-paced composites during entire direct runoff period[a]	Up to 15 maximum[b]	1 liter
SW100100	Time-paced composites during entire direct runoff period[a]	Up to 15 maximum[b]	1 liter

[a] Time pace will be based on location-specific hydrologic characteristics.

[b] If flow rates return to the baseflow rate before 15 grabs are collected, then a lower number will be collected. The full analyte suite can be competed as long as 11 grabs (11 liters) are collected.

3.2.5 Sample Handling and Analysis

Samples will be handled according to PRO.069, *Containing, Preserving, Handling, and Shipping of Soil and Water Samples,* and 1-PRO-079-WGI-001, *Waste Characterization, Generation, and Packaging.* If necessary, a Health and Safety Specialist (HSS) or Radiological Control Technician (RCT) will scan each sample with a Field Instrument for the Detection of Low Energy Radiation (FIDLER). Equipment will also be monitored for radiological contamination during and after sampling activities, if required.

Each composite sample will be analyzed for total radionuclides (Pu, Am, U), total metals, TSS, TOC, TDS, hardness, silicon, chloride, fluoride, and sulfate. The analytical requirements are outlined in Table 3-3. Samples will be submitted to offsite, EPA-approved laboratories for analysis under normal turnaround time constraints, unless shorter turnaround times are specified by the Project Manager and arranged with ASD.

Table 3-3. Analytical Requirements for Synoptic Surface-Water Samples.

Analysis	No. of Samples	EPA Method	Line Item Code	Container	Preservation	Holding Time
Am-241 Pu-239/240 Total Uranium	34[b]	N/A[a]	RC01B002	1 (one) 4-liter poly bottle	Unfiltered, HNO_3 to pH<2	180 days
Total metals; silicon	34[b]; plus 20 at GS10[d]	EPA 600 Total Recoverable	SS05C013; (SS05C001 CLP Total)	1 (one) 1L Poly	Cool, 4° C; HNO_3 to pH<2	180 days
TSS	34[b]	EPA 160.2 or Standard Methods 2540D	SS06B035	1 (one) 250 ml glass or poly bottle	Cool, 4° C	7 days
TOC	34[b]; plus 20 at GS10[d]	EPA 415.1 or SM5310,B,C,D	SS06B025	1 (one) 100ml glass	Cool, 4° C; H_2SO_4 or HCl to pH<2	28 days
TDS	34[b]; plus 6 at GS10[d]	EPA 160.1 or SM2540C	SS06B034	1 (one) 250 ml glass or poly	Cool, 4° C;	7 days
hardness	34[b]	EPA 130.2 or SM2340C	SS06B019	1 (one) 100ml poly/glass	HNO_3 to pH<2	180 days
chloride	34[b]; plus 20 at GS10[d]	EPA 300.0 or 325.3	SS06B010	1 (one) 250 ml poly	Cool, 4° C;	28 days
fluoride	34[b]; plus 20 at GS10[d]	EPA 340.2 or SM4500,B,F,C	SS06B018	1 (one) 250 ml poly	Cool, 4° C;	28 days
sulfate	34[b]; plus 20 at GS10[d]	EPA 375.1	SS06B037	1 (one) 100ml poly/glass	Cool, 4° C;	28 days
Rad Screen	20[c]	N/A[a]	D501A002	1 (one) 125 ml poly bottle	Cool, 4° C;	180 days

[a] No EPA-approved method is currently in place for radionuclide analyses.

[b] Includes three QC samples (2 duplicates, 2 rinsates) except for rad screens.

[c] Rad screens will not be required for SW022 and SW023.

[d] Average number of samples collected at GS10 since 10/1/96 during Apr. through Sep. that would have met the hold-time requirements for the parameter(s).

3.3 SEDIMENT SAMPLING

The following factors were considered in developing the sampling strategy for the sediment sampling:

- The Source Evaluation effort to date indicates that the study area may be a significant contributor of actinide load to GS10. Analysis also indicates that a source relatively 'enriched' in Am may exist in the study area.

- Environmental data and AME research to date indicate that actinide moves through the environment attached to soil particles, and that this soil is transported in surface-water as TSS. The soil particles that are most available for transport in surface water are the sediments in ditches where runoff is channelized and flows routinely. The sediment in these ditches would be representative of the soil particles that are moving with runoff.

3.3.1 Sediment Sampling Locations and Rationale

Sampling will occur along transects as shown in Figure 3-3. For this project, sampling transects are defined as sections of ditches or streams that convey surface water from defined sub-drainages. The selected ditches/stream beds are pathways for surface-water flow to GS10 that show evidence of soil and sediment transport. The initial sediment sampling location for each transect will be chosen to represent the downstream end of a specific sub-drainage just upstream from the confluence with the next higher order channel. The other sampling points along the transect are then equally spaced from the initial point until the end of the transect is reached. Existing sediment sampling locations will be targeted where appropriate so that comparative historical data can be incorporated in the evaluation. Decision errors related to sample collection location will be minimized by ensuring that the transects are clearly defined and accurate maps are used to locate sampling locations.

The locations have been further prioritized as Priority 1 and Priority 2. Priority 1 locations are locations that are recommended for analysis first, with Priority 2 locations reserved for subsequent analysis based on the results from the Priority 1 locations and the availability of resources. All locations will be sampled during the same time period, with the Priority 2 samples being stored for possible subsequent analysis.

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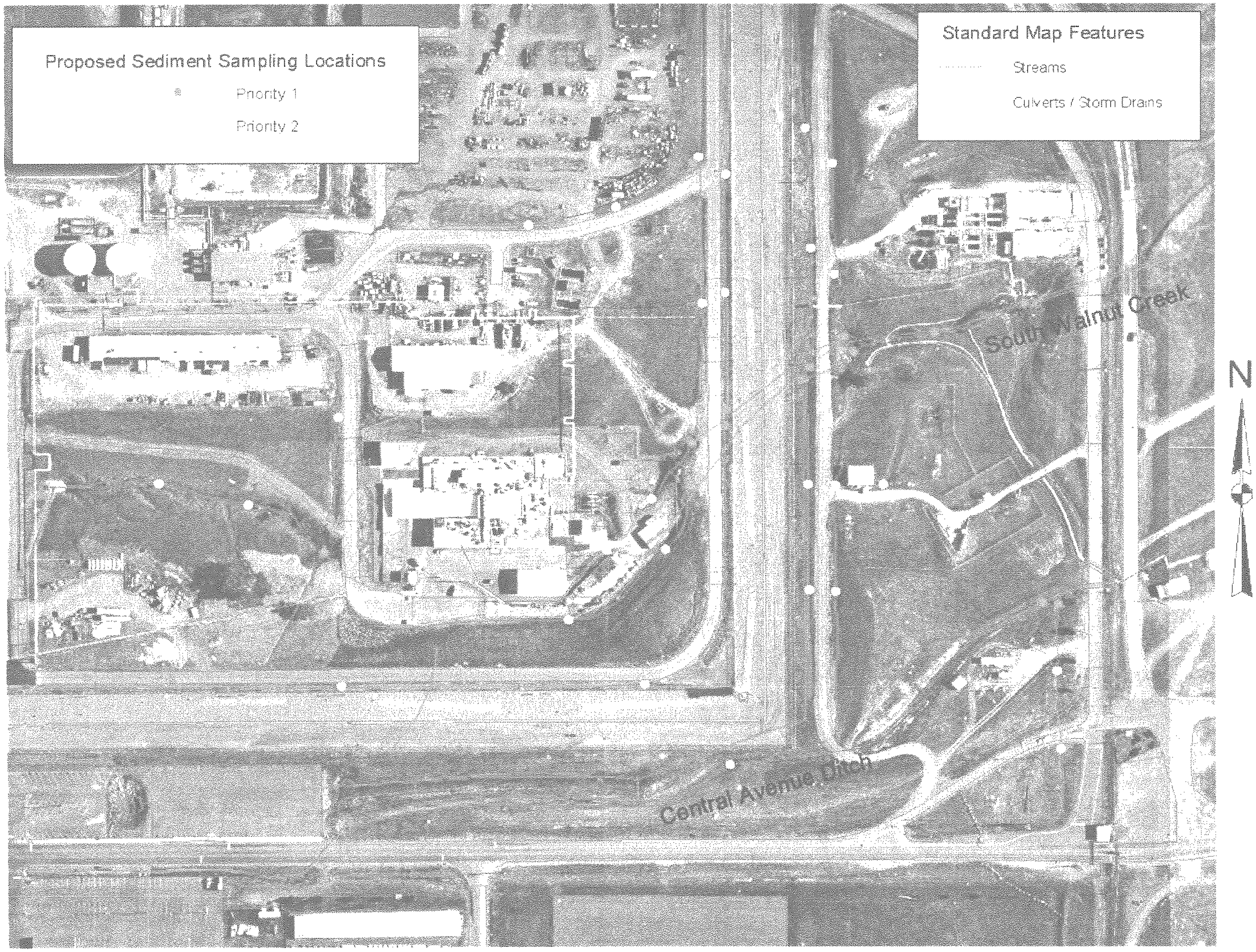

Figure 3-3. Location of Sediment Sampling Locations.

3.3.2 Sample Designation

The Site-standard sample numbering system (ASD-003, *Identification System for Reports and Samples*) will be used for this project. Location codes will be assigned to individual sampling locations as shown in Figure 3-3. Where sampling takes place at a pre-existing location, the existing location code will be used. For new locations, location codes will follow the format SED###MMYY where ## is a sequence number between 000 and 999, MM is the two digit numeric month, and YY is the two digit year. For each sediment sample a standard RIN sample number (i.e., 00XXXXX.00X.00X) will be assigned to the project by the Analytical Services Division (ASD) for sample tracking.

3.3.3 Sample Collection

Samples will be collected according to procedure RMRS/OPS-PRO.086 *Sediment Sampling*. Both Priority 1 and Priority 2 sediment locations will be sampled during the same period (shown in Figure 3-3). Sampling is expected to take 3 days weather permitting. Samples should be collected as close to the mapped (digitized) location as possible. The samplers will select an appropriate location to obtain representative sediment samples according to the procedure, and a location flag with the location code will be installed. The sampled location will be noted on the map if different from the digitized location. The depth and characteristics of the fine material will be logged.

Samples volume will be larger than required for the analytes described below such that additional soil and sediment will be available for subsequent analyses. The additional soil and sediment could be used for AME studies or analyzed for other constituents based on the results of other sampling activities in the same drainage. Each sample will be a target of 1500ml (approx. 4 kg) of material.

3.3.4 Sample Handling and Analysis

Samples will be handled according to PRO.069, *Containing, Preserving, Handling, and Shipping of Soil and Water Samples,* and 1-PRO-079-WGI-001, *Waste Characterization, Generation, and Packaging.* If necessary, a Health and Safety Specialist (HSS) or Radiological Control Technician (RCT) will scan each sample with a Field Instrument for the Detection of Low Energy Radiation (FIDLER). Equipment will also be monitored for radiological contamination during and after sampling activities, if required.

Priority 1 locations are locations that are recommended for priority analysis, with Priority 2 locations reserved for subsequent analysis based on the results from the Priority 1 locations and the availability of resources. All locations will be sampled during the same time period, with the Priority 2 samples being stored for any subsequent analysis.

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Each Priority 1 sample will be analyzed for total radionuclides (Pu, Am). The analytical requirements are outlined in Table 3-4. Samples will be submitted to an offsite, EPA-approved laboratory for analysis under normal turnaround time constraints, unless shorter turnaround times are specified by the Project Manager and arranged with ASD.

Table 3-4. Analytical Requirements for Sediment Samples.

Analysis	No. of Samples	EPA Method	Line Item Code	Container	Preservation	Holding Time
Am-241 Pu-239/240	46[b]	N/A[a]	RC01B009 (Am); RC01B014 (Pu)	500 ml wide-mouth glass	N/A	180 days
Rad Screen	44	N/A[a]	D501A003	4 oz (120ml) poly	N/A	180 days

[a] No EPA-approved method is currently in place for radionuclide analyses.

[b] Includes two QC samples (2 duplicates) except for rad screens.

3.4 EQUIPMENT DECONTAMINATION AND WASTE HANDLING

Reusable sampling equipment will be decontaminated with Liquinox solution, and rinsed with deionized or distilled water, in accordance with procedure RMRS/OPS-PRO.127, *Field Decontamination Operations*. Decontamination waters generated during the project will be managed according to procedure PRO.112, *Handling of Field Decontamination Water and Field Wash Water*. Personal protective equipment will be disposed of according to 1-PRO-573-SWODP, *Sanitary Waste Offsite Disposal Procedure*.

4. DATA MANAGEMENT

Project field logbooks will be created and maintained for each project by the project manager or designee in accordance with Site Procedure 2-S47-ER-ADM-05.14, *Use of Field Logbooks and Forms*. The logbook will include time and date of all field activities, sketch maps of sample locations, or any additional information not specifically required by the SAP. Appropriate field data forms will also be utilized when required by the operating procedures that govern the field activity. A peer reviewer will examine each completed original hard copy of data. Any modifications will be indicated in black ink, and initialed and dated by the reviewer. Logbooks will be controlled as required by procedure.

Analytical data record tracking for this project will be performed by KH-ASD. Sample analytical results will be delivered directly from the laboratory to KH-ASD in an Electronic Data Deliverable (EDD) format and archived in the Soil and Water Database (SWD). Hard copy records of laboratory results will be obtained from KH-ASD in the event that the analytical data is unavailable in EDD or SWD at the time of report preparation and later checked against electronic copy data when available.

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5. PROJECT ORGANIZATION

Figure 5-1 illustrates the project organization structure. The RMRS Project Lead will be the primary point of responsibility for maintaining data collection and management methods that are consistent with Site operations. Other organizations assisting with the implementation of these projects are: RMRS Health and Safety, RMRS Quality Assurance, RMRS Radiological Engineering, and KH-ASD.

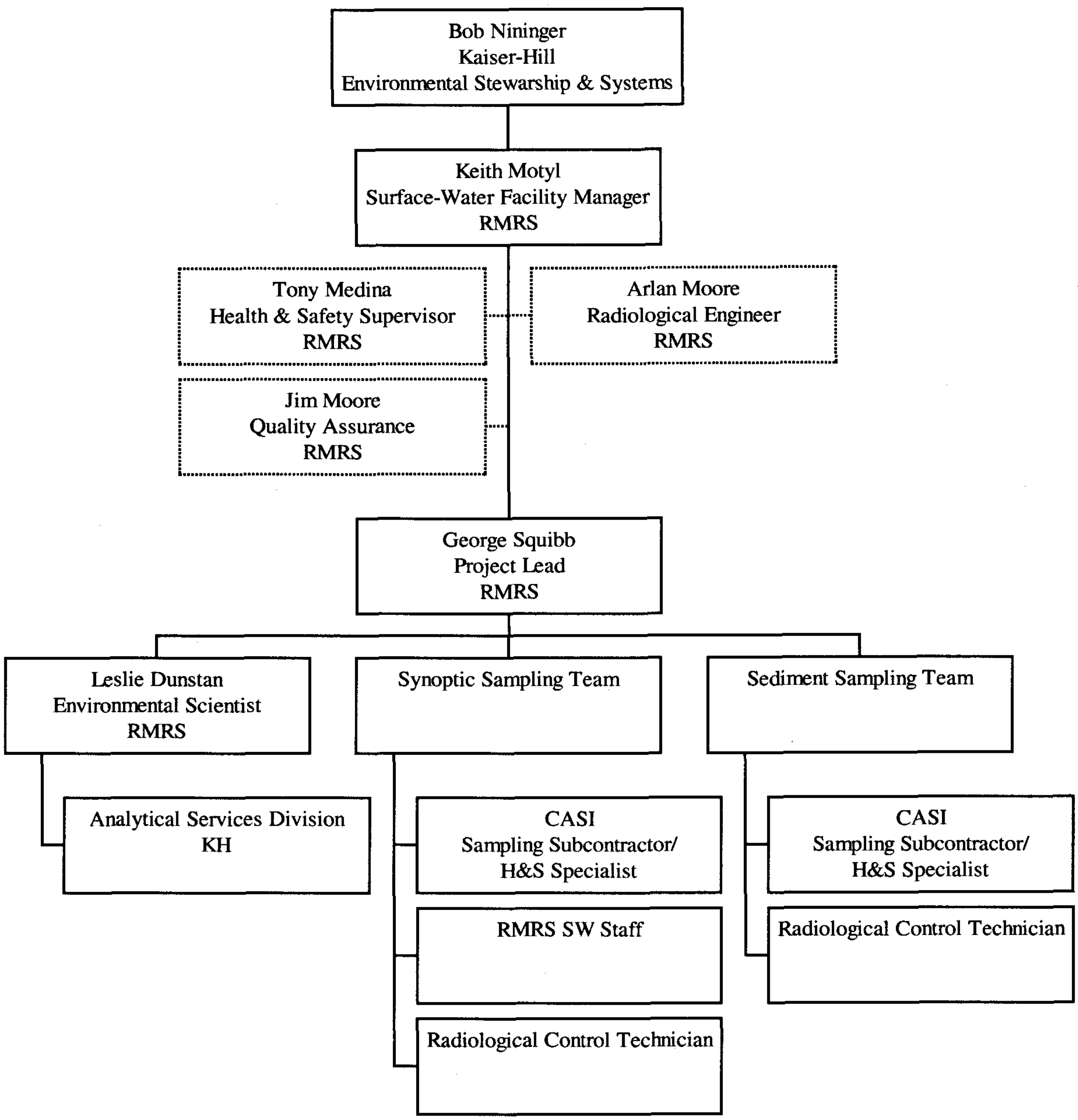

Figure 5-1. Project Organization Chart.

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Sampling personnel will be responsible for field data collection, documentation, and transfer of samples for analysis. Field data collection will include sampling and obtaining screening results. Documentation will include completing field logbooks and appropriate forms for data management and chain-of-custody shipment and as required by the appropriate governing SOPs. Commodore Advanced Sciences (CASI) will coordinate sample shipment for on-site and off-site analyses through the ASD personnel. CASI is responsible for verifying that chain-of-custody documents are complete and accurate before the samples are shipped to the analytical laboratories.

6. HEALTH AND SAFETY PLAN

All field activities contained within this SAP will be performed in accordance with the health and safety requirements set forth in the Site's *Safety Analysis Report* (Site SAR), the *Health and Safety Plan for Automated Surface-Water Monitoring in Support of the Rocky Flats Clean-up Agreement and the Industrial Area IM/IRA RF/RMRS-97SWHSP.01*, and the SPP Health and Safety Plan.

7. QUALITY ASSURANCE

All components and processes within this project will comply with the RMRS Qualify Assurance Program Description RMRS-QAPD-001 (RMRS, 1999c), which is consistent with the K-H Team QA Program. The RMRS QA Program is consistent with quality requirements and guidelines mandated by the EPA, CDPHE and DOE. In general, the applicable categories of quality assurance follow the Automated SW Monitoring Program Quality Assurance Program Plan (RMRS, 2000):

- Quality Program;
- Training;
- Quality Improvement;
- Documents/Records;
- Work Processes;
- Design;
- Procurement;
- Inspection/Acceptance Testing;
- Management Assessments; and
- Independent Assessments.

The project lead will be in direct contact with QA to identify and address issues with the potential to affect project quality. Field sampling quality control will be conducted to ensure that data generated from all samples collected in the field for laboratory analysis represent the actual conditions in the field. The confidence levels of the data will be maintained by the collection of QC and duplicate samples and equipment rinsate samples.

Duplicate samples will be collected on a frequency of 5% duplicate sample per project. Rinsate samples for surface-water locations will be generated at a frequency of 5% rinsate samples. Data validation will be performed on 25% of the laboratory data according to the Rocky Flats ASD, Performance Assurance Group procedures. Table 7-1 provides the QA/QC samples and frequency requirements of QA sample generation.

Table 7-1. QA/QC Sample Type, Frequency, and Quantity.

Sample Type	Project	Frequency	Comments	Quantity (estimated)
Duplicate	Synoptic Surface-Water Sampling	One duplicate for each twenty real samples		2 water
	Sediment Sampling	One duplicate for each twenty real samples		2 sediment
Rinse Blank	Synoptic Surface-Water Sampling	One rinse blank for each twenty real samples	To be performed with reusable sampling equipment following decontamination procedures	2 water

Analytical data that is collected in support of the two projects will be evaluated using the guidance developed by the RMRS Administrative Procedure RF/RMRS-98-200, *Evaluation of Data for Usability in Final Reports.* This procedure establishes the guidelines for evaluating analytical data with respect to precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters. A definition of PARCC parameters listed in Table 7-2 is included in the QAPP (RMRS, 2000). Quantitative values for PARCC parameters for the project are provide in Table 7-2.

Table 7-2. PARCC Parameter Summary.

PARCC	Radionuclides	Non-Radionuclides
Precision	Duplicate Error Ratio ≤ 1.96	RPD ≤ 30% for water; RPD ≤ 40% for water
Accuracy	Detection Limits per method and ASD Laboratory SOW	Comparison of Laboratory Control Sample Results with Real Sample Results
Representativeness	Based on SOPs and SAP	Based on SOPs and SAP
Comparability	Based on SOPs and SAP	Based on SOPs and SAP
Completeness	90% Useable	90% Useable

Laboratory validation shall be performed on 25% of the sampling data collected in support of the projects. Laboratory verification shall be performed on the remaining 75% of the data. Data usability

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shall be performed on laboratory validated data according to procedure RF/RMRS-98-200, *Evaluation of Data for Usability in Final Reports.*

Data validation will be performed according to KH-ASD *General Guidelines for Data Verification and Validation* (DA-GR01-v1), but will be done after the data is used for its intended purpose. Analytical laboratories supporting this task have all passed regular laboratory audits by KH-ASD.

8. SCHEDULE

Field activities will begin in early April 2000. Automated surface-water sampling will commence as soon as feasible following equipment installation. It is anticipated that field work for all projects will be completed by September 30, 2000.

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